CLEARING, GRUBBING, AND STRIPPING

CHAPTER 4

Land clearing is the removal and disposal of all vegetation, rubbish, and surface boulders embedded in the ground. In the TO, land clearing also includes the removal and disposal of mines, booby traps, and unexploded bombs. Grubbing is the uprooting and removal of roots and stumps. Stripping is the removal and disposal of unwanted topsoil and sod.

Clearing, grubbing, and stripping are accomplished by using heavy engineering equipment. Hand- or power-felling equipment, explosives, and fire are also used. Factors that determine which method to use are: the acreage to be cleared the type and density of vegetation, the terrain's effect on the operation of equipment, the availability of equipment and personnel, and the time available for completion. For best results, a combination of methods is used in a sequence of operations.

Clearing, grubbing, and stripping are the same in road and airfield construction. In airfield construction, the areas to be cleared are usually larger than for road construction; the number of personnel and amount of equipment used are correspondingly greater; and the disposal of unsuitable materials requires more detailed planning and longer hauls.

FOREST TYPES AND ENVIRONMENTAL CONDITIONS

Clearing, grubbing, and stripping operations differ in every climatic zone because each zone has different forest and vegetative types. Forests are not uniform in type, growth, and density within climatic zones. Soils, altitudes, water tables, and other factors vary widely within each zone.

The general nature of a forest is determined from records of the principal climatic factors, precipitation, humidity, temperature, sunlight, and the direction of the prevailing winds. The nature and action of climatic factors during the growing season determine the amount and types of forests. From these records, a general interpretation of the forests in an area can guide detailed reconnaissance.

The climate classifications of forests are temperate, rain, monsoon, and dry, The following paragraphs describe these classifications.

TEMPERATE FORESTS

Temperate forests contain both softwood and hardwood trees. Hardwoods are dominant where the soils are old, deep, and fertile. Softwoods are dominant where the soils are young, shallow, and less fertile. The density of growth in these forests varies with topography and local climate

conditions. Bogs are common in cold region, softwood forests. Bogs present a hazard to construction equipment during the clearing operations. Root systems vary according to geologic conditions and species. The types of root systems typical of various species are listed in Table 4-1.

RAIN FORESTS

Rain forests occur in tropical climates where rainfall is heavy throughout the year. They consist of tall, broad-leaved trees that grow as high as 175 feet. The trees have an umbrella-like foliage that permits little sunlight to penetrate. The undergrowth consists of thick vines that cling to the trees for support and grow to great heights. Where sunlight reaches the forest floor, the undergrowth is dense and varied. Because of continual precipitation, the root systems are on or near the ground surface and spread in a lateral pattern around the base of the trees,

MONSOON FORESTS

Monsoon forests occur in climates of heavy seasonal rains with strong, warm winds. The forests are dense, with varied species of hardwoods which are moderate-sized, broad - leaved, and have shallow root systems. The undergrowth is very dense with shrubs, vines, and plants.

DRY FORESTS

Dry forests occur in arid and tropical regions where there is little precipitation. The forests are either scrub or savanna. Scrub forests usually consist of broad-leaved hardwoods with dense thickets along watercourses. In open areas there are scattered growths of low, thorny, stunted shrubs and stunted trees that usually have long, tough taproots that are difficult to remove. Savanna forests are in more humid, dry-forest regions. These forests are park-like, with large trees widely and uniformly spaced. Savannas usually have continuous coverings of small grasses.

GEOLOGIC AND PERMAFROST CONDITIONS

An investigation of the geologic conditions of a forest can help when estimating the density and depth of the root systems of the trees. The investigation should be concerned with hardpan, marshy, and permafrost conditions.

Hardpan or Rock

Where a forest is closely underlaid by hardpan or rock, the tree roots branch and remain near the surface. This growth is easy to uproot. Where the soil is firm and the hardpan or rock is deep, the trees tend to form large, deep taproots that make uprooting difficult.

Inundated, Marshy, and Boggy Areas

In these areas, trees have thick, wide-spreading. and shallow root systems near the surface of the ground.

Permafrost

In northern regions where permafrost occurs, the root systems of trees are similar to those in hardpan or rock. Where the permafrost is near the surface, roots branch out and lie close to the surface. Where permafrost is far below the surface, trees develop taproots.

PREPARATION

RECONNAISSANCE AND PLANNING

The types of trees, vegetation, soil, and terrain encountered while clearing the land must be determined as accurately as possible from climatic and geological maps, intelligence reports, and aerial and ground reconnaissance. (Refer to Chapter 2 of this manual for more detailed in formation.) After such information has been verified, estimate the quantity of work, select the available equipment, determine the number of

Table 4-1. Species of trees and their normal root systems

Species	Normal Root System
Alder	Shallow, wide-spreading laterals
Ash	Deep in porous soils, shallow and spreading in rocky soils
Aspen	Shallow laterals
Basswood	Deep, wide-spreading laterals
Birches:	
Black, cherry, sweet	Deep, wide-spreading laterals
Paper, white	Shallow laterals
Yellow	Shallow, wide-spreading laterals
Cedars	Shallow, wide-spreading laterals
Cherry	Moderately deep, wide-spreading laterals
Chestnut	Taproot
Cypress	Several descending roots and many shallow, wide-spreading laterals
Elm	Shallow, wide-spreading laterals; occasionally a taproot
Firs:	
Balsam	Shallow, wide-spreading laterals
Douglas	Wide-spreading laterals
Lowland white	Deep, wide-spreading laterals
Noble	Moderately deep, wide-spreading laterals
White	Shallow laterals
Gums	Deep, wide-spreading laterals
Red, sweet	Shallow, wide-spreading laterals
Hackberry	Shallow, wide-spreading laterals
Hemlock	Shallow, wide-spreading laterals
Hickory	Deep taproot
Juniper	Deep laterals
Larch	Deep, wide-spreading laterals
Laurel	Deep, wide-spreading laterals
Locust	Deep, wide-spreading laterals
Magnolia	Deep, wide-spreading laterals
Mahogany	Shallow, wide-spreading laterals
Maple	Shallow, wide-spreading laterals
Oak	Deep taproot
Pine:	
Eastern white	Moderately deep; no taproot
Jack	Moderately deep, wide-spreading laterals
Loblolly	Short taproot (young), laterals
Lodgepole	Deep, wide-spreading laterals; always with taproot
Longleaf	Deep taproot; well-developed laterals
Nut	Shallow to moderately deep laterals
Pitch	Taproot (young); later laterals
Ponderosa	Moderately deep, wide-spreading laterals
Red, Norway	Strong taproot and laterals
Shortleaf	Very deep taproot
Slash	Deep, strong taproot with laterals
Stone (Foxtail)	Taproot supplemented by laterals
Sugar	Taproot (seedlings), deep laterals
Western white	Taproot (seedlings); deep, wide-spreading laterals
Poplar	Shallow laterals
Yellow	Deep, wide-spreading laterals
Quassia	Shallow, wide-spreading laterals
Redwoods	Several descending and many shallow, wide-spreading laterals
Spruce	Shallow, wide-spreading laterals
Sycamore	Shallow laterals
Tamarack	Shallow, wide-spreading laterals
Willows	Wide-spreading laterals

personnel needed, and plan a sequence of operations to complete the clearing rapidly and efficiently. In all clearing operations, the decisive factors controlling the method of clearing are the type and amount of equipment and the time available for completion.

TIMBER CRUISING

Timber cruising is performed to estimate the size, the height, and the number of each tree species in a given area. It is used either to determine the quantity of usable timber or to estimate the amount of work required in clearing. A sample, usually 10 percent of the area, is studied and the result is applied to the entire area. The sample may be increased or decreased. In small areas, a 100-percent cruise is usually made.

In timber cruising for land clearing only, record the diameters of the trees at breast height (DBH) taken at 4 1/2 feet above the ground, and record the species and number of trees. This information is used to plan the clearing operation and select the type of equipment most efficient for the diameters and species.

CLEARING CONSIDERATIONS

PERMAFROST

Clearing of ground cover over permafrost which is near the freezing point may result in thawing of material, causing considerable ground-surface subsidence.

SAFETY

Careful consideration must be given to the safety of personnel and equipment during clearing operations. Protective, tractor-mounted cabs should be used when extensive clearing operations are anticipated. Protective cabs permit greater flexibility in clearing operations and increase operator efficiency. With this protection, damage to the dozer is reduced and continuous production results.

Proper supervision and planning can help prevent accidents caused by falling trees, uprooted stumps, stump holes, and rough or broken terrain during the clearing operation. All equipment used in clearing should, if practicable, be equipped with heavy steel plating for protection of the undercarriages. This will prevent stumps, logs, and boulders from damaging vulnerable equipment parts.

CAMOUFLAGE

To provide cover and concealment (camouflage) for the construction site, do not remove standing trees and brush outside the designated cleared area unless necessary. When uprooting trees with bulldozers, take care to control their fall and avoid breaking surrounding trees.

TIMBER SALVAGE

Trim all timber useful for logs, piles, and lumber, and stockpile it for future use in bridge, culvert, and other construction applications. Push or skid this timber into a salvage area where it can be moved to a sawmill with little difficulty.

TEMPORARY DRAINAGE

Phased development of the drainage system in the early stages of clearing, grubbing, and stripping is essential to ensure uninterrupted construction. Delays caused by flooding, subgrade failures, heavy mud conditions, and the subsequent immobilization of construction equipment can be eliminated by careful development of the drainage system before, or concurrent with, other construction. Use the original drainage features as much as possible

without disturbing natural grades. Grade drainage ditches downhill.

Fill holes left by uprooted trees and stumps with acceptable soil, and compact the ground to prevent the accumulation of surface water. Use dozers and graders for this work. Slope the ground toward drainage ditches to prevent pending on the surface. Backfill existing ditches at the latest possible time to permit the best use of the original drainage.

DISPOSAL

Use waste areas or burning to dispose of cleared materials. The choice of method depends on the type of construction, environmental concerns, the location, the threat, and the time available. Generally, the material is pushed and skidded off the construction site and into the surrounding timber to speed disposal and keep the area cleared for equipment operation. To dispose of material as rapidly as possible, assign specific units of equipment to accomplish this concurrently with the clearing and grubbing. The disposal method should be consistent with the methods of camouflage, salvage, and drainage used for clearing.

WASTE AREAS

In airfield construction, consideration must be given to the areas used for disposal of construction waste.

Dumps Adjacent to Work Areas

In forward combat areas where saving time is essential, the quickest and most convenient method of material disposal is to pile the materials adjacent to the work area. Study the construction plans to determine where the debris can be piled without interfering with drainage or potential work areas.

Off-Site Areas

In constructing the main project, it may be necessary to clear some adjacent land to dispose of the cleared material. Locate this clearing as close to the main project as possible to shorten the hauling distance, Use the same methods to clear disposal areas that arc used in clearing work areas.

Revetments

Cleared material can be disposed of by using it as fill material in revetments around hardstands when protective measures are needed.

Burning

Do not use fire for clearing land unless suitable equipment and sufficient personnel are not available for other methods of clearing. When burning is required, closely follow recommended procedures.

Under favorable tactical conditions, brush and timber debris may be burned. To limit the likelihood of detection because of smoke, keep fires burning as hot as possible and do not push new material into the fire rapidly. Do not permit fires to burn at night unless tactical conditions are extremely favorable and approval has been obtained from headquarters.

Fire Control. Strip the area around any debris to be burned before fires are started to provide a firebreak. If large areas are to be burned, establish firebreaks on all sides as a precaution against shifting winds. Maintain a fire guard over the fires as an additional safety measure. In dry weather, hand shovels, water buckets, and other expedient fire-fighting equipment should be available to extinguish fires caused by flying sparks.

Burning Pits. The most satisfactory method for burning large quantities of brush and timber is to burn them in a pit or trench dug by a bulldozer or scraper. The sides of the pit will reflect the heat back into the fire, producing a very hot fire, Burning will be rapid and complete. Push the material into the pit with a bulldozer. Start the fire with limbs and small brush to get a good bed of coals. Gradually increase the size of the material as the intensity of the fire increases. Get as little dirt as possible in the pit because it tends to smother the fire and fill the pit. A soldier should be detailed to

tend the fire and ensure that the pile is kept compact, This method cannot be used in swampy areas where groundwater will seep into the trench.

Log Piles. If it is not desirable to construct burning pits, burn piles of logs by loosely piling them so that the heat and flames can pass through, It is always best to start the fire with brush. After a large bed of coals is formed, add a few logs at a time to obtain a good blaze.

To burn piles of green, wet logs, it may be necessary to use fuel oil to furnish enough heat to dry out the logs and start the burning process. Pile the logs parallel, one on top of the other. The fuel oil is carried to the center of the pile by a pipe in which holes have been drilled or cut. Once the pile is burning well, the fuel can be cut off and the pipe removed. Care must be taken to avoid ground contamination.

Fuel oil is also a quick and convenient means of starting brush fires, particularly if the brush is green and wet. If material is to be pushed onto the pile while the pipe is being used, it is best to bury the portion of the pipe outside the pile to protect it from damage from tractor grousers and bulldozer blades.

Clearing and Piling Stumps. In preparing stumps for burning, remove as much dirt as possible from the roots. Dirt on the roots will retard combustion and smother the fire. When the stumps are pushed out, leave them with the roots exposed to sun and wind so the dirt till dry quickly. Scrubbing with the side of the bulldozer blade will knock off much of the dry dirt. Pile the stumps as close together as possible with the trunks pointing toward the center of the pile. Keep the stumps together after they start to burn. This procedure will speed up the burning.

AIRFIELD APPROACH ZONES

Airfield glide angles and approach zones are further discussed in Chapter 11 of FM 5-430-00-2/AFPAM 32-8013, Vol 2. Obstructions extending above the glide angle must be removed. Although glide-angle requirements may be met by only topping trees, it is best to fell or uproot trees that extend above the glide angle. Disposal is no problem in the approach zone, because all demolished material is left in place.

PERFORMANCE TECHNIQUES

CLEARING WITH EQUIPMENT

The use of engineer equipment is the most rapid and efficient method of clearing. The use of such equipment is limited only by un usually large trees, stumps, and terrain that decrease the maneuverability of the equipment and increase maintenance requirements. This type of equipment includes bulldozers; tree-dozer, tractor - mounted units; tractor -mounted clearing units; winches; power saws; rippers; and motor graders. In addition, pioneer tools are used for some clearing operations. Table 4-2 summarizes the limitations and proper applications of engineer equipment in clearing operations. Use production rates of equipment under normal operating conditions for determining the total time required for the job. Clearing rates are discussed in FM 5-434. Limitations and applications for each type of equipment follow.

Bulldozer

When clearing an area in dry or temperate forests, the bulldozer is the most efficient mechanical equipment for removing small brush, trees, and stumps up to 6 inches in diameter. Although more time and effort are required, bulldozers can also remove trees up to 30 inches in diameter when tractor-mounted clearing units and power saws are not available. Because of its ability to push, move, and skid felled trees and brush, the bulldozer is used extensively as the primary unit of equipment in all clearing operations.

Table 4-2. Applications and limitations of engineer equipment in land clearing

Equipment	Applications	Limitations
Bulldozer	-Primary equipment for all land clearing. -Excellent for removing brush, trees, and stumps up to 6 inches in diameter. -Push, pull, or skid cleared material for disposal.	-Trees over 6 inches in diameter require special and slower methods of removal by dozer. -Maneuverability limited in muddy or swampy terrain and in dense, heavy growth.
Tree-dozer, tractor-mounted unit (Rome Plow)	-Medium clearing of brush and trees at ground level rather than uprooting.	-Skilled personnel required for cutting of trees; other units required for completion of clearing when burning is not permitted.
Tractor-mounted clearing unit	-For extensive clearing operations requiring heavy pulling. -Uproot trees and stumps of almost unlimited diameters. -Skid cleared material for disposal. -Extricate mired equipment. -Excellent for operation in jungles, swamps, and bottom lands with heavy growth.	-Skilled personnel required for rigging. -Slow in clearing an area; other units required for speedy completion. -Not TOE.
Winches (towing):		
Tractor-mounted	-For general light and medium pulling. -Uproot trees and stumps up to 24 inches in diameter. -Skid cleared material for disposal. -Extricate mired equipment.	-Pulling capacity limited by size of tractor. -Terrain affects maneuverability of tractor.
Truck-mounted	-Expedient for light pulling of trees up to 6 inches in diameter. -Skid small trees and brush. -Extricate mired equipment.	-Rigging personnel required. -Terrain must be suitable for truck use. -Pulling capacity too limited for most operations.
Felling equipment:		
Chain saw	-Controlled felling of trees of almost unlimited diameters. -Saw timber for salvage. -Rapid felling.	-Other units required for uprooting stumps and disposing of felled timber. -Pneumatic saws are very dangerous to use on steep, rugged ground. Air hoses frequently are fouled and broken by rolling logs and chunks. Gasoline chain saws are far easier to handle than the pneumatic ones because there are no hoses to contend with. They can be used in any type of terrain with a reasonable degree of safety if operated by skilled operators.

Table 4-2. Applications and limitations of engineer equipment in land clearing (continued)

Equipment	Applications	Limitations
Circular or chain saw mounted on tractor	-Saw timber for salvage. -Rapid felling. -Excellent for clearing heavy, dense growth in rough and broken terrain.	-Other units required for uprooting stumps and disposing of felled lumber. -Maneuverability limited in muddy or swampy terrain and in terrain too steep for tractor to negotiate. -May bind in unbalanced tree, requiring extensive looping of tractor pull line.
Ripper	-Cut free roots. -Loosen surface boulders. -Loosen soil for stripping.	-Depth of shank penetration limits use to shallow roots. -Maneuverability limited in muddy or swampy terrain and in dense, heavy growth.
Grader	-Light clearing of grass, weeds, and small brush/vegetation. -Windrow cleared material. -Grade cleared area for drainage.	-Maneuverability limited to level terrain free of trees, stumps, and boulders. -Careful operation required to prevent damaging blade.

When clearing with bulldozers, the sequence of operations depends on the type of trees, the terrain, and planned construction. After establishing the boundaries of the clearing, select spoil areas for disposal of all cleared material based on the shortest haul, a downgrade slope, effective camouflage, and general accessibility.

Start clearing at the disposal area and move in each direction away from it. Use one or two dozers to clear the small trees and brush only. Another pair of dozers will remove the larger trees and stumps bypassed by the previous units. If necessary, add more dozers for a third cycle of operation to take care of the heaviest removals.

Move the cleared material to the spoil area by skidding, pushing, or pulling. Disposal should be done with uprooting and removing. It is best to have a separate crew assigned for disposal.

Multiple operations are possible when other types of equipment are available, using each type where it is most effective. Use power saws, for example, to fell large trees. Use clearing units to uproot large stumps and work in areas inaccessible to dozers. Use bulldozers to clear, stockpile, and dispose of light material. The operational methods used by bulldozers in clearing depend on the size of the trees. The methods briefly discussed below are discussed fully in FM 5-434.

Small Trees, 6 Inches or Less in Diameter, and Brush. In clearing small trees and brush, operate the bulldozer with the blade straight and digging slightly. It may be necessary to back up occasionally to clear the blade. The cleared material can either be pushed into windrows for later removal or pushed off to one side of the area to be cleared.

Medium Trees, 6 to 12 Inches in Diameter. To push over trees that range from 6 to 12 inches in diameter, set the blade of the bulldozer as high as possible to gain added leverage (Figure 4-1). As the tree falls, the

4-8 Clearing, Grubbing, and Stripping

bulldozer is backed up quickly to clear the roots. With the blade lowered, the dozer travels forward again and digs the roots free by lifting the blade. The felled tree is then ready for removal to the spoil areas.

Large Trees. Removing large trees (over 12 inches in diameter) is much sIower and more difficult than clearing brush and small trees. First, gently and cautiously probe the tree for dead limbs that could fall and injure you. Then, position the blade high and center it for maximum leverage. Determine the direction of fall before pushing the tree over; the direction of lean, if any, is usually the direction of fall, If possible, push the tree over the same as you would a medium tree.

However, if the tree has a large, deeply embedded root system, use the following method (Figure 4-2, page 4-10):

Step 1. Opposite the direction of fall, make a cut deep enough to cut some of the large roots. Use a V-ditch cut around the tree, tilted downward laterally toward the tree roots.

Step 2. Cut side two.

Step 3. Cut side three.

Step 4. To obtain greater pushing leverage, buld an earth ramp on the same side as the original cut. Then push the tree over. As the tree starts to fall, reverse the tractor quickly to get away from the rising root

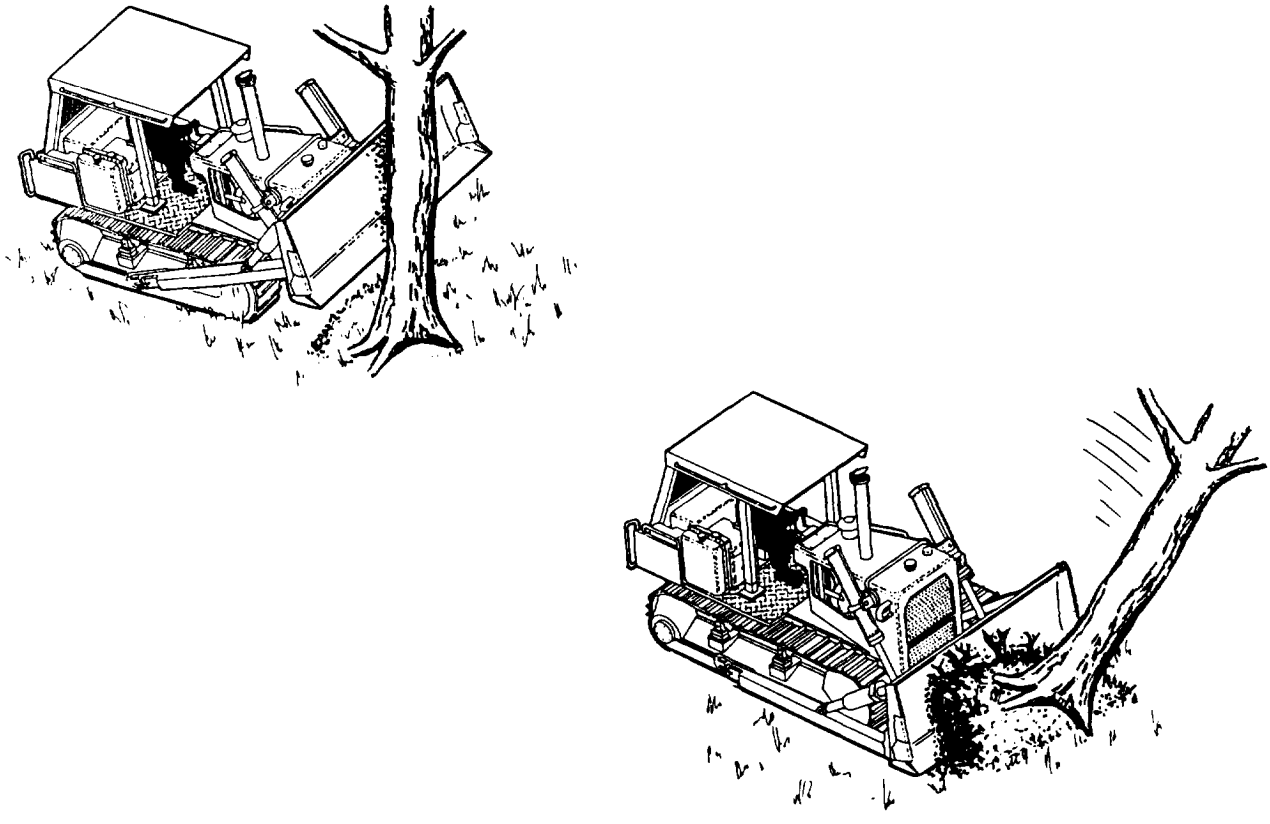

Figure 4-1. Bulldozer removing medium-sized trees, 6 to 12 inches in diameter

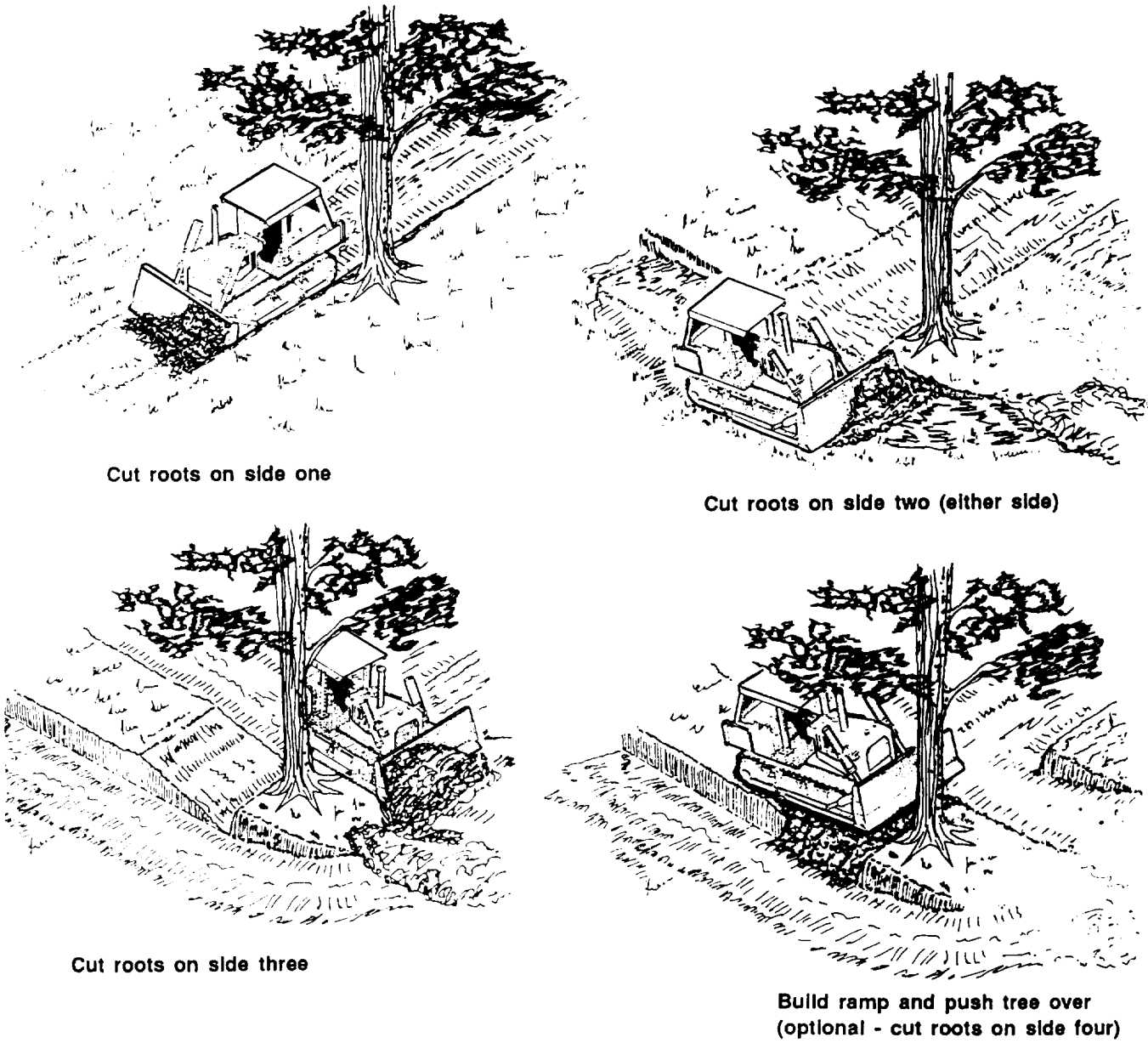

Figure 4-2. Four steps for removing large trees with a bulldozer

mass. After felling the tree, fill the stump hole so that water will not collect in it.

NOTE: The roots on the fourth side may need to be cut also.

Tree-Dozer, Tractor-Mounted Unit

The tree-dozer, or Rome plow, is a tractor with a blade that *stings* and *slices* large trees. A sharp projection on the left side of the blade splits the trees, while the cutting edge shears them off at ground level. The operator is protected by a steel canopy and a guide bar that controls the direction of falling trees.

The tree-dozer is a simple and efficient piece of equipment used for military land-clearing operations. It does not appreciably disturb the soil. It provides—

- Clear fields of fire and security around cantonments, airfields, and other facilities.

- Right-of-way clearance to desired depths along roads and railroads, thereby reducing the enemy's capability of ambush.

Before committing a tractor equipped with the tree-dozer mounting, investigate the soil condition in the area of operation to determine if it will support the equipment. Use the tree-dozer mounting to make cuts through any kind of forest except heavy swampland. Shear trees at ground level, sweep them into piles or windrows, and dispose of them. One tractor equipped with a tree-dozer mounting can clear approximately 1 to 2 acres per hour, depending on the tree density and size. Use one of the following clearing methods:

Ž When the tractor can move forward almost continuously, it shears to ground level anything in its path, Fast production can be obtained by laying out long areas (200 to 400 feet wide) that can be cut from the outside toward the center in a counterclockwise direction. The cut material then slides off the trailing (right) end of the tree-dozer mounting and leaves the uncut area free of fallen debris. The windrows are placed lengthwise on the borders of the areas. Piling is done by sweeping with the tree-dozer mounting. Sweep a blade width at a time. Work from the center of each area, at a right angle to the border (Figure 4-3).

Ž Another method is shown in Figure 4-4, page 4-12. Again, long areas are laid out in 200- to 400-foot widths, but the cutting is done from the center toward the sides in a clockwise direction. This allows the cut material to fall toward the center, which becomes the windrow site. The piling is done with the tree-dozer mounting, following the pattern outlined on the right side of Figure 4-4. When windrowing, the operator keeps the cutting edge on the ground while pushing into the windrow and raises it

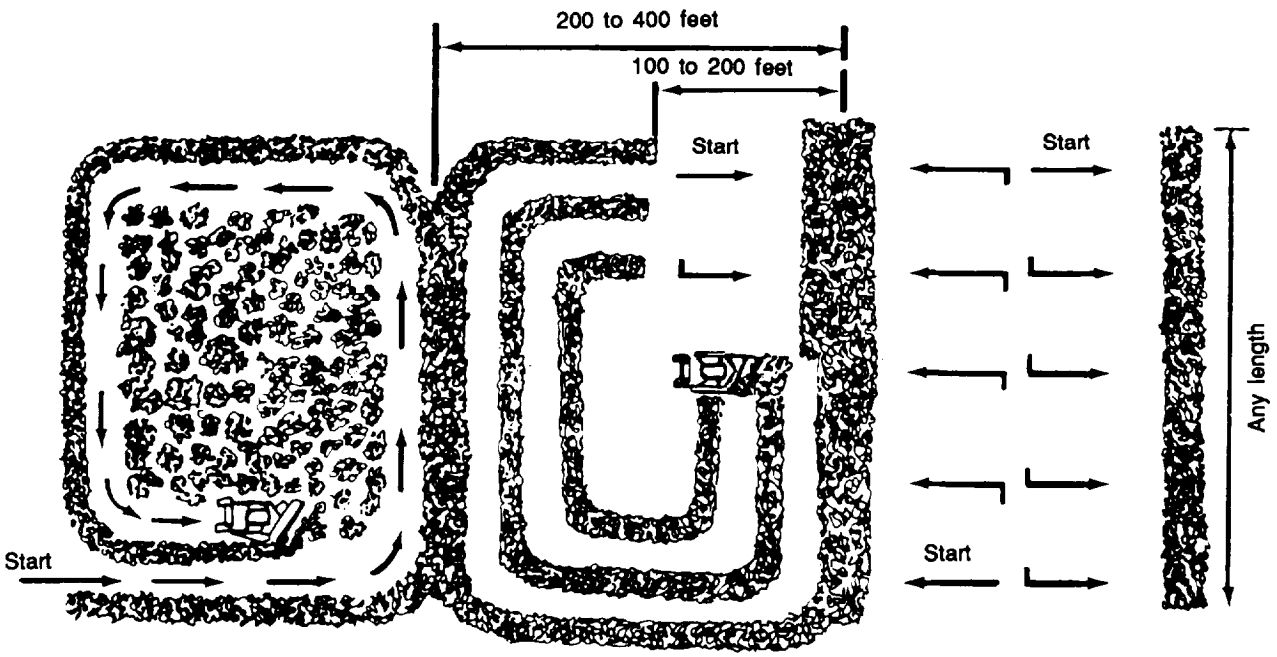

Figure 4-3. Cutting vegetation to ground level and piling cut material using the counterclockwise method

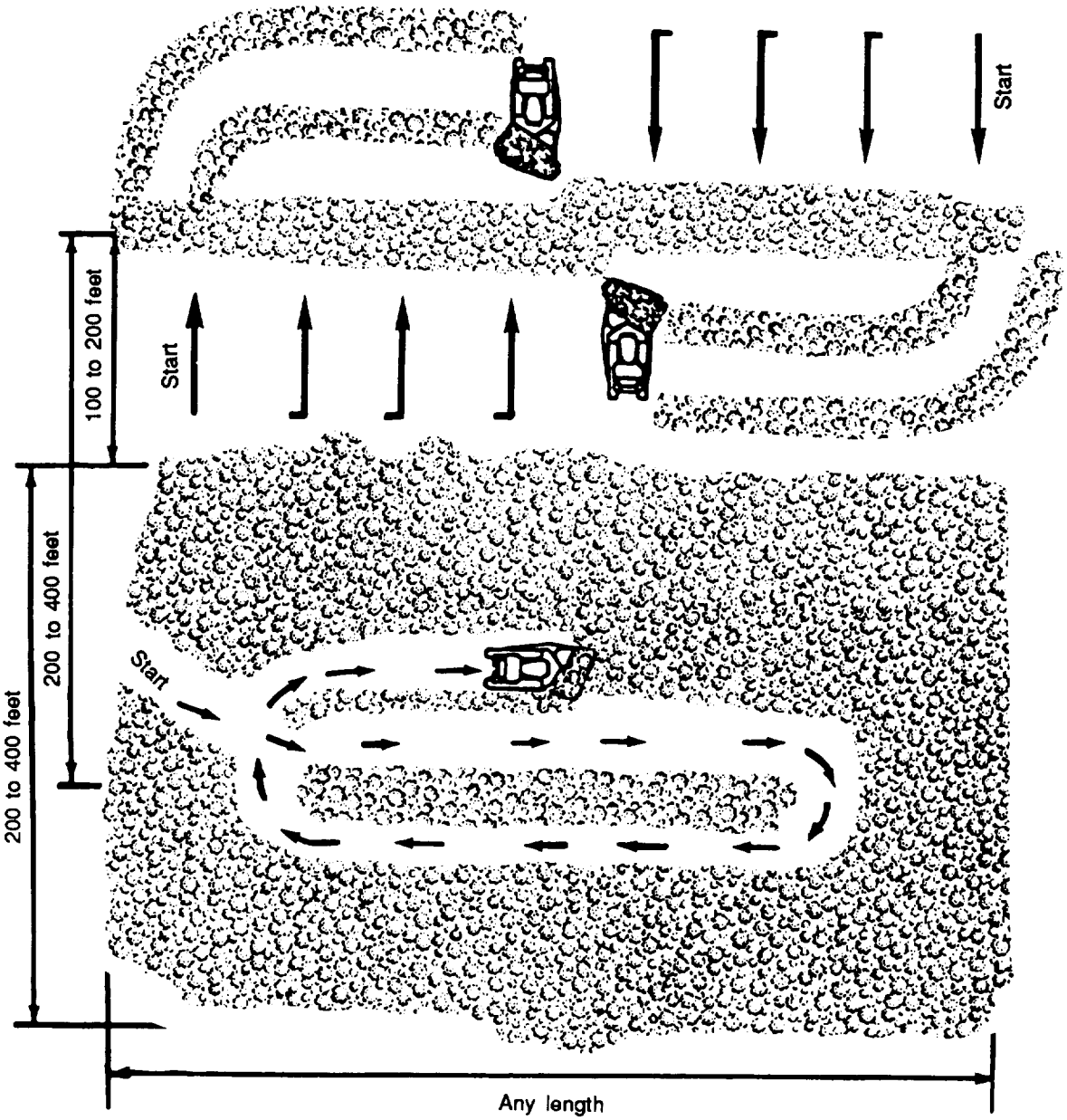

Figure 4-4. Cutting vegetation to ground level and piling cut material using the clockwise method

when backing away. This allows accumulated soil to sift away and lessens soil deposits in the windrow.

- On extreme slopes, rapid production is obtained by working in a semicircular pattern, from left to right, at approximately right angles to the windrow (Figure 4-5). If the terrain is steep, the windrows should be on the contour, and the tractor should work from the uphill side and push downhill to the windrow.

- Where the vegetation is dense and small, the highest production can be obtained by cutting and windrowing simultaneously. Work from left to right at a

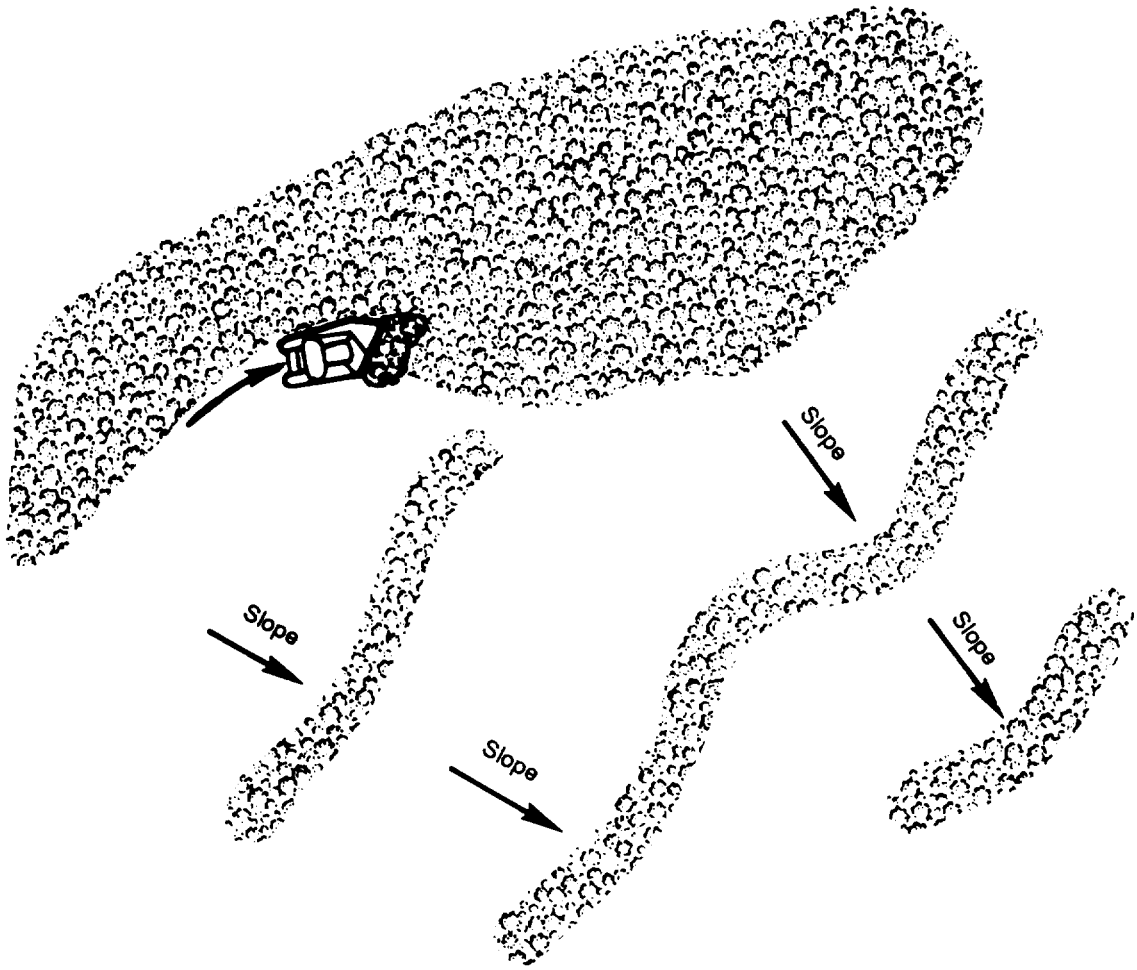

Figure 4-5. Clearing on steep slopes covered with large trees

90-degree angle to the windrow, with the trailing edge of the tree-dozer working against the uncut material. This prevents cut material from sliding off the moldboard and allows the cut material to accumulate on the mold board.

When the moldboard is filled, the operator should stop the tractor and deposit the cut material. The operator should then reverse to the starting point and repeat the operation to the right (Figure 4-6, page 4-14), reducing the time lost in backing up. When the tractor reaches the previously cut material, the operator should deposit cut material and form another windrow.

The area of vegetation should be laid out as shown in Figure 4-6, with the operator working in patches, from inside to outside in a counterclockwise direction and at right angles to the windrows. Sweeping and piling the resulting debris can be accomplished much faster when tractors are used in teams traveling abreast.

Winches

Towing winches mounted on tractor-dozer units or trucks are limited in use for clearing operations because of their small capacities in comparison with the tree- and stump-pulling units.

Tractor-Mounted Winch. Use tractor-mounted winches for uprooting trees and stumps up to 24 inches in diameter.

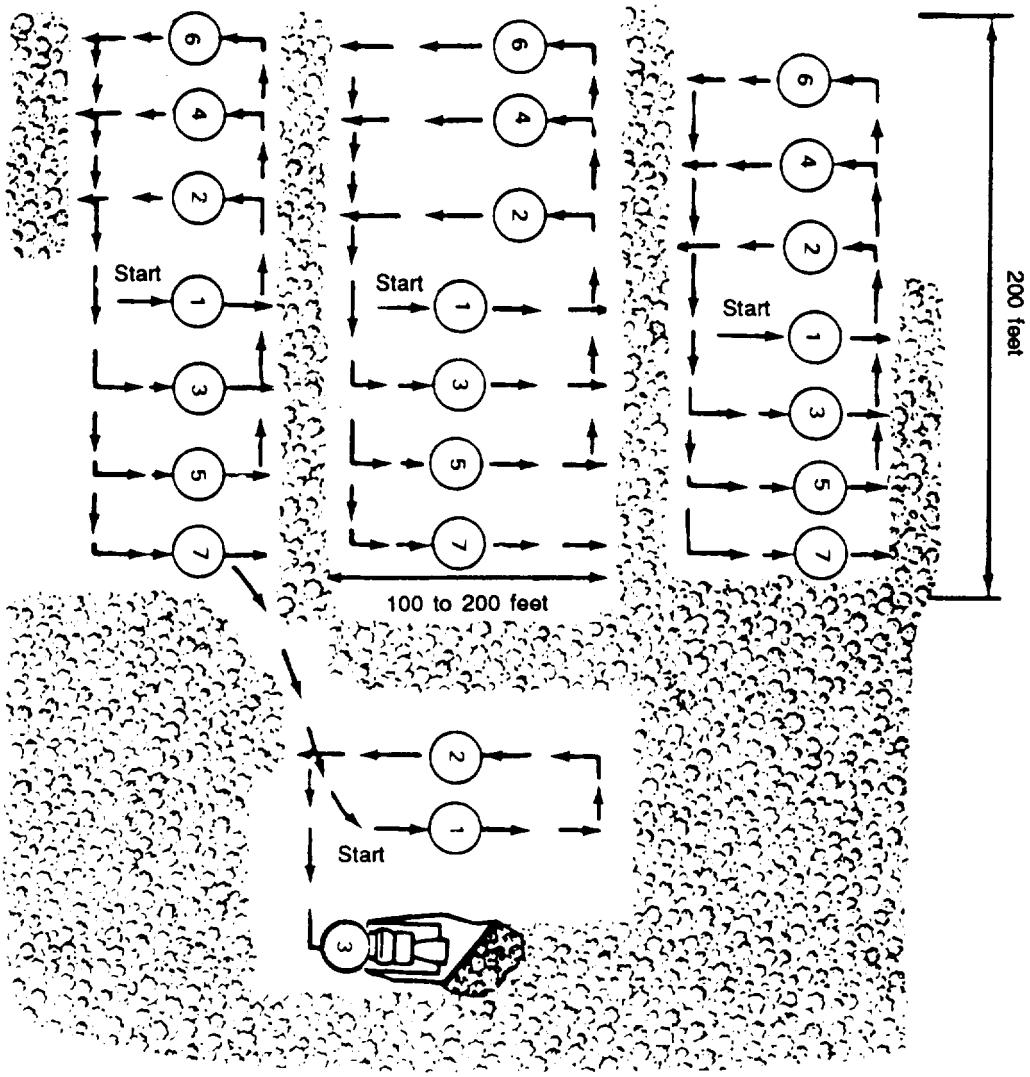

Figure 4-6. Cutting and piling dense growths of small-diameter vegetation on level terrain

hoisting and skidding felled trees, and extricating mired equipment. On the tractor-dozer unit, the winch is mounted in the rear and is directly geared to the rear power take-off on the tractor. The line pull developed varies with the size of the tractor, the speed at which the winch is operated, and the number of layers of rope on the drum. The line pull of a tractor-mounted winch is only about one-half the pull of a standard tree- and stump-pulling unit.

Truck-Mounted Winch. As an expedient, truck-mounted winches can be used on trees up to 6 inches in diameter. Their capacities are too limited for heavy work. Their best use is for skidding felled trees and logs to a disposal area, if the haul road is sufficiently cleared for trucks to operate.

Felling Equipment

Felling can be done with hand tools or power equipment. Axes, two-man saws, shovels, pick-mattocks, and machetes are used to chop or saw down standing timber; dig and uproot stumps: and slash grass, vines, and undergrowth. Clearing by hand is usually too slow and difficult for military requirements unless explosives or mechanical methods are used. When labor is

plentiful, forests are dense, and terrain is rough, this method of clearing can be used with good results. Power equipment and chain and circular saws are the principal ways of felling limber.

Ripper

In land clearing, the ripper is used to help in the removal operations of bulldozers and tree- and stump-pulling units. The ripper cuts and breaks tree roots and loosens boulders from the ground. The short depth of shank penetration limits its use to shallow root systems. Prior to stripping operations, the ripper is used to loosen and break up frozen soil or organic material for easier removal by graders or scrapers.

Grader

The grader is used 10 cut grass and weeds, remove small brush, and clear the area of dead vegetation. The terrain must be level and free from boulders and trees. Used with rippers and bulldozers, graders can windrow the cleared material for later removal by other equipment. The grader is extremely limited in most clearing operations.

CLEARING WITH EXPLOSIVES

Explosives may bc used to fell standing trees, uproot entire trees and stumps, and remove and dispose of large boulders. Explosives, however, have several disadvan - tages. The sound of the explosive can travel farther than the sound of the construction equipment. In loose soil, the initial charge may be entirely a expended in compacting the soil under a tree or stump, and a second charge may be required to remove it. Deep taproots often are only broken by explosives and have to be removed by hand. Also, explosives generally take time to place and they create large craters, which require borrow excavation and compaction to backfill. In spite of these disadvantages, it is still sometimes necessary to use explosives to clear an area where the terrain precludes or seriously impedes the operation of heavy equipment. Refer to FM 5-250 for the correct application of explosives and demolitions.

Trees and Stumps

Methods of tree and stump blasting vary with the size and condition of the tree, root structure, and ground conditions, Figure 4-7, page 4-16, shows the methods of placing charges to blast stumps with different root structures. Table 4-1, page 4-3, shows the type of root system for several tree species in temperate forests.

The size of the charge required depends on the strength of the explosive available; the size, variety, and age of the tree or stump; and soil conditions.

Various types of tools (such as pinch bars, earth augers, and spoons) can be used when drilling holes for the charge. Wood augers can be used for taproots. For loading and tamping, any smooth, wooden pole about 5 feet long and 1 1/2 inches in diameter can be used. The handle from a long-handled shovel is excellent because the crook of the blade end provides a good grip. All holes must be tamped firmly with earth to retain the full force of the explosion.

Boulders

When boulders cannot be used in an embankment or fill, they must be removed from the construction area. Blasting is a quick and easy method of dislodging boulders. Mudcapping, blockholing, or snakeholing (described in Chapter 3 of FM 5-250 or Chapter 6 of FM 5-34) may be used. Refer to Chapter 3 of TM 5-332 for quantities and types of explosives to be used and details regarding blasting rock.

REMOVAL OF SURFACE ROCKS

All surface rocks must be removed in certain types of construction. There are three methods used in this operation: hand, bulldozers, and cranes or scoop loaders with trucks. The choice of method depends upon the situation.

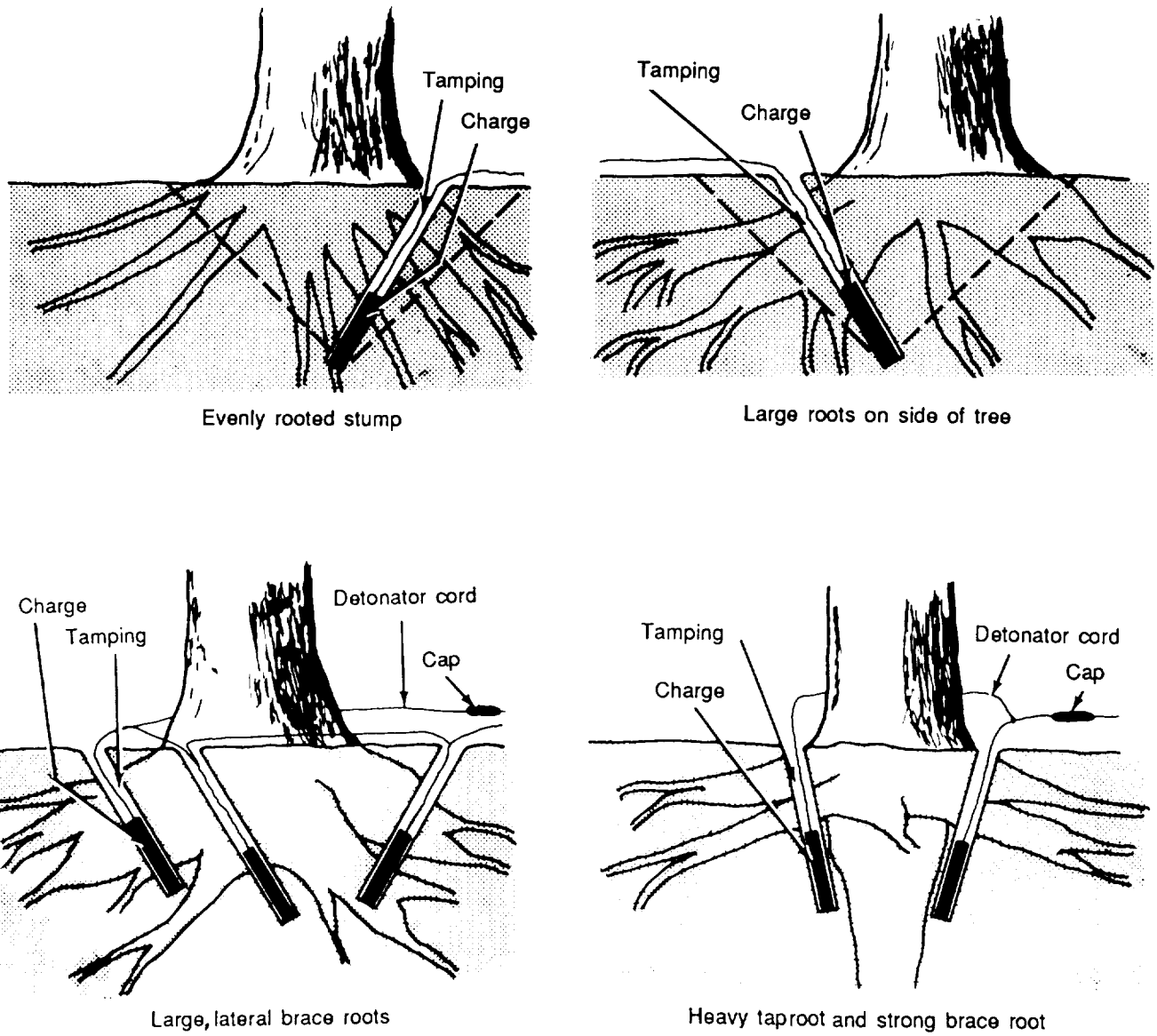

Figure 4-7. Stump-blasting methods for different root structures

Hand

When there is sufficient time and personnel, rocks are picked up and loaded into hauling units by hand. This slow method is used in military construction only as an expedient.

Bulldozer

The bulldozer is the most commonly used engineer equipment for moving rocks to a fill or disposal area. The rocks may be windrowed by dozers for later removal by scrapers or shovels and trucks. If the distance is short, they may be pushed by dozers to the designated disposal area.

Cranes or Scoop Loaders with Trucks

Clearing surface rock by this method alone is possible, but it is slow. If the rocks are first windrowed or moved into piles by bulldozers or graders, the shovel will load the trucks quickly and efficiently. The

rocks can then be hauled long distances for disposal.

STRIPPING

Stripping consists of removing and disposing of the topsoil and sod that cannot be used as a subgrade, foundation under a fill, or borrow material. Examples of this material are organic soils, humus, peat, and muck, Unsuitable soil must be removed to a depth at which compaction and thickness requirements are satisfied. Stripping is done concurrently with clearing and grubbing by using bulldozers, graders, scrapers, and sometimes shovels, Good topsoil and sod should be stockpiled for later use on bare areas for dust or erosion control or for camouflage.

REMOVAL OF STRUCTURES

An airfield construction site may be acceptable except for obstructions such as houses, railroads, power lines, and other structures on the proposed site or near the operation of aircraft. The primary selection of a site always involves compromises, The survey party often selects a site where limited clearing of structures will be necessary before full-scale operations can take place.

Power Lines

Power lines obstructing forward area construction or glide angles should be removed. In rare instances, the lines may be needed intact and a different approach to the airfield must be used. If the lines cross the runway, relocate them around the nearest end of the runway. As a last resort, underground installation may be used if armored underground cable or conduit is available that will adequately insulate the lines, In rear areas, power lines that are not in an approach zone or not high enough to extend into the glide angle when located in an approach zone may be marked with suitable warning lights.

Roads and Railroads

In general, roads and railroads present no obstructions when located near airfields, if the traffic does not interfere with the approach or takeoff of aircraft. Do not destroy main paved highways and railroad lines because they may be required for ground operations. It is desirable to have the airfield located near a good road or railroad so supplies may be readily transported to the site.

Buildings

Buildings may be completely razed with explosives or heavy equipment, leaving no salvage. They may be razed in a manner to conserve usable material, or they may be relocated.

REMOVAL OF BURIED EXPLOSIVES

Mines, booby traps, unexploded ordnance (UXO), and other buried explosives must be located and removed or neutralized before any construction operations begin. Check all reports and data on an area to locate and identify explosives.

Establish the boundaries of the construction area first, then make a visual search of the most likely places for explosives. They are usually near existing structures, houses, and roads; in disturbed ground hollows where the earth has visibly settled; and under stockpiles, pickets, or stakes placed in unnatural locations. If time allows, thoroughly investigate the area with mine detectors or by probing methods.

The safety of personnel and equipment is primary at all times during the removal of mines. The speed of clearance is secon - dary, Whenever possible, use trained explosive ordnance disposal (EOD) detachments, particularly when the size of bombs precludes detonation in place.

The method of mine and UXO removal is a command decision. For minefield with booby traps or other antihandling devices, it is best to destroy the mines in place by explosives or mechanical means. UXOs may be disarmed by ordnance personnel and then manually removed from the area and disposed. If ordnance personnel are not available, destroy the device in place.

Surface mines or bomblets may be able to be pushed from an area by using a drag chain or dozer. If devices are destroyed in place, all resulting holes and craters must be filled and compacted with acceptable material, using dozers or graders. For additional information, see FM 5-434.